

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
26 April 2001 (26.04.2001)

PCT

(10) International Publication Number  
**WO 01/28512 A1**

- (51) International Patent Classification<sup>7</sup>: **A61K 7/48, 7/50**
- (21) International Application Number: **PCT/US00/41054**
- (22) International Filing Date: **3 October 2000 (03.10.2000)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:  
**09/420,472**      **19 October 1999 (19.10.1999)**      **US**
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- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— *With international search report.*  
— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: SELECTIVE REMOVAL OF CONTAMINANTS FROM A SURFACE USING ARTICLES HAVING MAGNETS

(57) Abstract: A system and method for removing contaminants from a surface. The system is designed to use particles having means thereon which are capable of selectively binding to a contaminant or contaminants of interest. The particles are applied to the surface whereupon the contaminants bind to the particle. When the particle is removed, the desired contaminants are also removed. Preferably, the present invention utilizes magnetic particles having iron therein. The particles may then be readily removed using magnets. The means for binding the contaminant to the particle preferably comprise a ligand or a charge specifically designed to remove the contaminant of interest. The particles may be included in a carrier to facilitate their application to the surface. The invention is especially useful for the removal of contaminants from skin.



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## SELECTIVE REMOVAL OF CONTAMINANTS FROM A SURFACE USING ARTICLES HAVING MAGNETS

### FIELD OF THE INVENTION

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The present invention is directed to a system and method whereby contaminants may be selectively removed from skin. In particular, the present invention is directed to a system and method which uses particles having a degree of magnetism wherein the particles are constructed and arranged to remove particular contaminants, such as microbial contaminants and debris, further wherein the particles and the contaminants are then removed from the skin using articles containing magnets.

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### BACKGROUND OF THE INVENTION

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Humans have vast amounts of debris and microbes existing in their bodily fluids and on their skin. Many of the microbes are beneficial to the health and well-being of the individual. However, many of these microbes are contaminants which are not beneficial. Many of these non-beneficial microbes exist in body fluids which contact the skin, such as tears, perspiration, oils, nasal secretions, and bodily waste. The microbes may also exist in wounds. These microbes, along with debris contaminants, may irritate the skin causing a variety of skin problems such as rashes,

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breakouts, clogged pores, or discoloration of the skin or, with wounds, slow down the rate at which the wound will heal.

5 Many different products have been produced to help eliminate the problems associated with debris and the non-beneficial microbes. Different cleaning products are used which include detergents. These detergents effectively remove excess oils and fluids, thereby reducing the number of both beneficial and non-beneficial microbes. However, the non-beneficial microbes still exist on the skin, just in lower  
10 numbers. Additionally, if too much oil is removed from the skin, then dryness of the skin could result.

Other products have introduced microbiocides which are effective at killing all microbes on the skin. However, since these microbiocides eliminate beneficial  
15 microbes as well as non-beneficial microbes, these products destroy beneficial skin ecology and thus have a negative impact on skin health.

Accordingly, what is needed is a system and method of removing debris and non-beneficial microbes from  
20 skin without removing beneficial microbes to help reduce the skin problems associated with the non-beneficial microbes while maintaining skin health.

## SUMMARY OF THE INVENTION

25 The present invention is directed to a system and method of removing microbial contaminants from skin. The system utilizes receptor materials which selectively bind to the microbe or microbes of interest. The receptor materials are placed on the surface of the skin wherein they attach to and  
30 bind the microbes. Then, the receptor material and bound microbes are removed from the skin. This allows non-beneficial microbes to be removed while beneficial microbes remain, thereby maintaining skin health or expediting the healing of wounds.

The system preferably includes the use of particles onto which the receptor materials are placed. These particles are designed to be placed on the skin wherein the receptor materials may bind to the desired microbes. Then, means are provided which remove the particles and the accompanying receptor material and microbes from the surface of the skin.

Preferably, the present invention utilizes particles which have a magnetic charge. Then, after these magnetic particles are used to remove the microbes, articles having magnets contained therein or thereon may be used to remove the magnetic particles from the skin.

Accordingly, it is an object of the present invention to provide a system which can selectively attach and remove desired microbes.

It is another object of the present invention to provide a system which maintains skin health by removing non-beneficial microbes while permitting beneficial microbes to remain on the skin.

It is still another object of the present invention to provide a system which removes non-beneficial microbes while not drying or otherwise damaging the skin.

It is still another object of the present invention to provide a system which utilizes magnetic particles and magnets to aid in the selective removal of the non-beneficial microbes.

It is still another object of the present invention to provide a method of removing non-beneficial microbes from skin.

It is still another object of the present invention to provide a method of removing non-beneficial microbes by utilizing particles which selectively bind to the non-beneficial microbes on the skin and, upon removal of the particles, carry off the non-beneficial microbes.

It is still another object of the present invention to provide a method of removing non-beneficial microbes by utilizing magnetic particles and magnets.

5 The present invention can also be used with a multitude of different personal care items such as diapers, tissues, feminine products, wipes, bandages, and cleansing materials.

10 These and other objects and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 outlines the test procedure by which an embodiment of the present invention was used to determine the effectiveness of the magnetic test strips.

Figure 2 is a graphical representation of the effectiveness of the present invention at removing *E. coli* attached to skin.

20 Figure 3 a graphical representation of the effectiveness of the present invention at removing *C. albicans* from skin using Magnetic Cellulose Particles.

#### DETAILED DESCRIPTION

25 The present invention is directed to a system and method for removing contaminants from skin. The system may be used to remove a wide range of contaminants such as debris or microbes. The system preferably utilizes ligands which bind to the contaminant of interest. Then, the ligands and the bound contaminants are removed leaving desirable  
30 microbes to maintain skin health.

The ligands are associated with particulate materials which are applied to the skin whereupon the ligand or charge can bind to the contaminant of interest. Then, means are provided which remove the particulate material. In  
35 the preferred embodiment of the present invention, the

particulate materials have a magnetic charge and these magnetic particles are removed through the use of article having magnets contained therein or thereon. Depending on the desired use, these magnets may be located within a personal care product. Preferably, the system employs reactive superparamagnetic monodispersed microspheres (SMM) that are coated with ligands to specifically bind the target microbes.

Alternatively, instead of attaching a ligand, the magnetic particles may be either positively or negatively charged to thereby attract and bind other desired microbes and contaminants. The charge may be given to the particle by at least two methods. One would be to use material that already has the appropriate charge. This would be example by the use of cellulose to impart an overall negative charge. Conversely, chitin could be used to impart an overall positive charge to the particle. The second method would be to modify the materials by chemical means to change the charge characteristic of the surface. For example, addition of amines would impart a positive charge addition of carboxyl groups a negative charge.

Native silanol groups on the surface of silica microspheres are readily reacted with aqueous or solvent-based silane coupling agents to yield preactivated silica microspheres with a large variety of surface functional groups. Examples include chloromethyl, carboxyl, and amino groups. Oligonucleotides can be covalently bound to surface-modified silica via the 5'-amino end. Lipids can be bound via the carboxyl group on the fatty acid chain and propylamine surface groups on the silica.

The present invention also includes methods of removing contaminants from skin by applying particles having the ability to selectively bind to a contaminant or contaminants of interest. Then, the particles are removed from the skin to clear away the undesirable contaminants. By "selectively bind" is meant that the particles can adhere to certain intended

contaminants and not adhere to certain other non-intended materials.

In the preferred embodiment, the present invention utilizes magnetic particles. Preferably, these magnetic particles comprise a particle containing iron. Preferably, the particle is non-toxic and is capable of binding a ligand thereto. Particles useful in the present invention include those made from natural polymers, random copolymers, or plastics. Representative examples include natural polymers such as cellulose; random copolymers such as polybutylene copolymer, polyethylene, polypropylene copolymers, polyethylene elastomers; and plastics such as polystyrene, polyethylene, polypropylene, rayon, nylon, polyvinylidene chloride, and polyesters, chitin, starch, dextran and modified-starch. Silica could be used as an inorganic carrier. Other inorganic carriers might include clays. The type of particle used will vary depending several considerations, including the intended use or the contaminant to be removed. However, in general, natural polymers, such as cellulose, impregnated with iron are the preferred type of particle.

The size of the particle may also vary depending on the intended use or the product in which the particle is to be used. However, if the particle is too large, it may aggravate the skin as it is applied. Therefore, in general, the preferred particle are smaller in size. Preferably, the particles are less than about 25  $\mu\text{m}$  in diameter. More preferably, the particles are from about 3-4  $\mu\text{m}$  in diameter.

The amount of iron contained within each particle will vary depending on the amount of charge desired, the overall size of the particle, the carrier within which the particles will be applied to the skin, if any, and the location and number of magnets used to remove the particle. However, in general, the particles will comprise from about 1% to about 25% by weight of iron. More preferably, the particles will

comprise from about 10% to about 20% by weight of iron. This will result in the particle having a magnetic mass susceptibility of from about 50,000,000 to about 200,000,000 m<sup>3</sup>/kg.

5                   Once the desired particle type, size and iron content have been selected, then the particle may be modified to either attach a ligand thereto or charged to obtain the desired polarity. As discussed previously, the choice between  
10                   a ligand or ligands and a charge will depend upon the type of contaminant to be removed and will affect the composition of the particle. If a charge is used, the charge may either be a positive charge or a negative charge. If a ligand is used, it may be selected from a wide variety of useful ligands.

15                   A positively charged particle is capable of being used to remove yeast and bacteria (negatively charged) and any negatively charged molecule. Examples of particles useful as positively charged particles include, but are not limited to, diethylaminoethyl,                   ciethyl[2-hydroxypropyl]aminoethyl, polyethyleneimine, triethylaminohydroxypropyl, quaternary  
20                   ammonium,                   quaternary                   alkylamine,                   quaternary alkylanolamine,                   trimethylbenzylammonium, dimethylethanolbenzylammonium, polyamine, alkylamine, dimethylethanolamine, octadecyldimethyltrimethoxysilpropylammonium                   chloride,  
25                   and kymene.

30                   A negatively charged molecule may be used to remove protein and other biological contaminants, not including yeast or bacteria. Examples of particles useful as positively charged particles include, but are not limited to, carboxymethyl cellulose, sulfopropyl cellulose, cellulose phosphate, DOWEX®, DUOLITE®, AMBERLITE®, bentonite, and chitin.

                  A large number of ligands may be used in the present invention. These ligands include plant lectins and



antibodies among others. Furthermore, extracts of plants and natural products may also be used.

5 Plant lectins useful in the present invention include, but are not limited to, lentil lectin, wheat germ lectin, dolichos biflorus, galanthus nivalis, glycine max, heli pomatia, lens culinaris, phaseolus vulgaris, phytolacca americana, ulex europaeus, and vicia villosa. These lectins are useful at removing microbial materials, and especially any cells with mannopyranosyl or glucopyranosyl residues on the membrane surface. They may also help in the removal of proteins or skin debris with similar characteristics. Other microbes which may be removed include those having glucose, mannose, or n-acetyl-glucosaminyl residues in the microbes cell wall and other skin debris material.

15 Other ligands which may be used include *dolichos biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex europaeus*, and *vicia villosa*.

20 Antibodies useful in the present invention include those having specific antibodies for any microbe associated cell wall or membrane component. Other ligands useful in the present invention include those that use cell surface receptors specific for microbes. These include, but are not limited to, *Staphylococcus*, *Streptococcus*, *Candida*, and *Propionibacterium*. All of these are specific for cell surface receptors which bind glycosides. Those glycosides could be attached to the magnetic particle.

25 If a ligand is used as the means for removing the contaminant, then the ligand must be attached to the particle such that when the particle is applied to the skin, the ligand is able to bind with the contaminant or contaminants of choice and remove these contaminants when the particle is removed from the skin. There are a plurality of known methods which may be used to attach the ligand to the particle. However, the

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preferred methods for the present invention include direct adsorption and covalent attachment.

Direct adsorption involves adsorbing the ligand onto the surface of the particle. Simply adsorbing protein, especially polyclonal IgG, on the surface of polystyrene microspheres is successful more than 95% of the time. For maximum surface coverage (up to a monolayer), buffer pH should be at, or slightly more basic than, IgG's isoelectric point (that is, pH 8), where the protein is in its most relaxed, compact form. Tris buffer (pH 8.0) and phosphate buffer (pH 7.4) work well. The Fc and Fab portions of IgG adsorb differently in response to pH changes. A slightly alkaline pH optimizes adsorption of the Fc portion and ensures relative suppression of Fab adsorption.

As an alternative to simple adsorption, IgG and serum albumin (human or bovine) can be mixed and then adsorbed simultaneously. One commercial protocol calls for a weight ratio of 1 IgG to 10 albumin in the coadsorption mixture. Adsorption can be followed by glutaraldehyde cross-linking of the mixed proteins on the microsphere surface.

In covalent bonding, the ligand is covalently bonded to the particle. For example, haptens and other low-molecular-weight labels, which on their own might not adsorb well or remain attached, can be covalently bound to proteins (such as BSA), dextran, polylysine, or other polymers that adsorb well. Another alternative is to adsorb the polymer on the particles and then couple the hapten or other label. These polyhaptens are used commercially. Another embodiment is to adsorb peptide onto the microspheres and then covalently link more peptide onto the surface.

Also, any polyclonal antibody (PoAb) may also be used, such as those from mouse, goat, rabbit, pig, or bovine. These polyclonal antibodies adsorb well and attach to microspheres to form generic microspheres. These then capture any of several poorly adsorbing monoclonal antibodies

(MoAb). In theory, a manufacturer can make a series of tests (or assays) from one PoAb preparation.

Some evidence indicates that one can attach 10-40% more protein covalently than by adsorption. When the desired protein coverage is low, covalent coupling may provide more-precise control of the coating level. Covalent coupling binds protein more securely, an asset in production of tests or assays that are so sensitive that they would be influenced by minute quantities of IgG that might leach off the particles over time. The covalent bond is more thermally stable.

Native silanol groups on the surface of silica microspheres are readily reacted with aqueous or solvent-based silane coupling agents to yield preactivated silica microspheres with a large variety of surface functional groups. Examples include chloromethyl, carboxyl, and amino groups. DNA and RNA are isolated from serum by adsorption onto silica in the presence of chaotropic agents. Oligonucleotides can be covalently bound to surface-modified silica via the 5-amino end. Lipids can be bound via the carboxyl group on the fatty acid chain and propylamine surface groups on the silica.

After the particles have been charged or attached with a ligand, they are then ready to be applied to the skin to remove contaminants therefrom. While the particles may be applied directly to the skin, it is preferred that they be included with a carrier designed to aid the application of the particles to the skin while reducing the number of particles needed to effectively remove the desired contaminants. The carrier may be any means that permit the effective distribution of the particles over the desired area of the skin. These carriers include, but are not limited to, lotions, creams, sprays, or solutions. Other natural carriers may be used, such as alginate or chitosan. Additionally, the particles may be

applied using a non-magnetic, cellulosic or polymeric wipe which is wiped across the surface of the skin.

The amount of particles added to the carrier will depend on several factors including the carrier used, the contaminants to be removed and the amount of contaminants, among others. In general, from about 0.001 to about 10 mg of particles will be included per milliliter of carrier. More preferably, the amount of particles will be from about 0.1 to about 1.0 mg/ml.

As previously discussed, the present invention preferably uses magnetic particles. Magnetic particles are used such that they may be easily removed through the use of magnets. The magnets are associated with a product, such as a personal care item. The manner in which the particles are applied to the surface and the type of product used to remove the particles will vary, depending on the contaminant to be removed and the surface area to be treated.

The magnets used in the present invention are selected so as to be incorporated into the personal care product such that they are still capable of removing the magnetic particles. The magnets may be incorporated into both woven and non-woven materials, depending on the product. Additionally, the woven and non-woven materials may be composed of natural or synthetic fibers, or a mixture of both. For example, in one embodiment, the magnets may be incorporated into facial tissues, which comprise plant fiber. In another embodiment, the magnets may be incorporated into a non-woven fabric, such as a diaper or a wipe. However, since these two embodiments result in different contact of the product with the skin, the products must be designed accordingly. For facial tissues, the magnets will come into close contact with the skin. Therefore, the number, size and/or strength of the magnets will be different when compared to magnets placed inside a diaper, which do not directly contact the skin, yet must still be able to remove

magnetic particles which may have been incorporated into lotion or powder applied before the diaper was put on.

The present invention also includes methods of removing contaminants using the system of the present invention. While it is expected that the system is capable of removing contaminants, such as debris or microbes, from a skin surface, it is also contemplated that the mechanisms described below may also permit the system to be used to remove contaminants from a wide variety of surfaces including, but not limited to, skin, floors, windows, pets, automobiles, watercraft, and counter tops.

In use, means for removing the contaminant are associated with a particle. As previously discussed, these means may involve the attachment of a ligand or generating a charge on the particle. After the means for removing the contaminant are associated with the particle, the particle is then applied to the surface. The particles may either be applied directly, such as using a wipe, or may be included in a carrier which is applied to the surface. After the particles have been applied, the contaminants to be removed bind to the means for removing the contaminant. Then, the particles are removed from the surface using means for accomplishing the same. When the particle is removed from the surface the contaminant is also removed.

This invention is further illustrated by the following embodiments, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

In one embodiment, the magnetic particles may be placed in a carrier, such as a cream, lotion, spray or solution,

and applied to an open wound. These particles could be associated with a ligand capable of removing bacteria from the wound. Then, the magnetic particles could be located in the gauze or bandage which is wrapped around the wound. Once the bandage contacted the wound, the magnets would pull the magnetic particles and contaminants from the wound. In a similar manner, the particles may be associated with a charge or another ligand and used to treat a variety of different rashes or infections.

In another embodiment, the magnetic particles may be associated with a ligand or charge that is capable of binding to microbes existing in bodily wastes. Then, the particles may be applied to, for example, a baby using a baby wipe, powder or lotion. The particles would bind with the microbes. Then, a diaper having magnets contained therein may be placed on the baby, wherein the magnets would remove the magnetic particles and contaminants from the skin of the baby, helping to prevent rashes. Similar embodiments may be used with feminine articles or adult incontinence devices.

In still another embodiment, the particles may be used to help clear pores and prevent breakouts of the skin. The particles would be associated with a ligand or charge that is capable of binding to debris or microbes existing on the skin surface. The particles may be included in a carrier such as a cream or lotion. Then, the particles are applied to the skin surface whereupon they bind with the debris or microbes. Then, an adhesive strip having magnets contained therein may be applied to the skin. When the strip is removed, the magnetic particles and contaminants would also be removed, helping to clear the pores. Alternatively, a facial wipe may be used in lieu of the adhesive strip.

In still another embodiment, the particles may be used to relieve the symptoms associated with sinus problems. Irritation of the skin around the nose may be associated with

microbes in the mucous. To remove these microbes, particles having the necessary ligand or charge may be applied to the nose using a carrier such as cream, lotion, or facial tissue. Then, the particles and the microbes bound thereto may be removed using another facial tissue having magnets contained therein.

As can be seen, the particles of the present invention may be used in many different embodiments depending upon the contaminant to be removed, the surface being treated, the carrier used, and the means for removing the particles and contaminants. It should be understood, of course, that the foregoing embodiments relate only to some of the preferred embodiments of the present invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

## EXAMPLES

In the Examples, *ex-vivo* skin test strips were prepared. These strips were then used to determine the effectiveness of the present invention at removing *C. albicans* or *E. coli* from skin. Figure 1 outlines the magnetic removal protocol used for these Examples. The Examples were performed as follows:

### Procedure:

1. Make tape strips, 5 pulls per tape strip on forearm.
2. Place tape strips in wells of 6 well plate.
3. Block with 2.0 ml 5% Bovine Serum Albumin (BSA) in Phosphate Buffered Saline (PBS), pH 7.2.
4. Incubate 30-32 °C, 100 RPM, 1 hr.
5. Aspirate wells of 6 well plate dry.
6. Wash tape strip with Tris Buffered Saline (TBS pH) 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.

7. Add 1.0 ml ( $10^6$  CFU/ml) *C. albicans* or *E. coli* in TBS pH 7.4 to each well.
8. Add 1.0 ml Typtic Soy Broth (TSB) to each well.
9. Incubate 30-32 °C, 100 RPM, 1 hr.
- 5 10. Aspirate wells of 6 well plate dry.
11. Wash tape strip with TBS pH 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
- 10 12. Add 2.0ml 1/200 Rabbit anti-*C. albicans*-Horseradish Peroxidase (HRP) or Rabbit anti- *E.coli* -HRP in TBS pH 7.4 + 0.5% BSA.
13. Incubate 28-30 °C, 100 RPM, 1 hr.
14. Add 2.0ml 1/200 Sheep anti-rabbit-paramagnetic bead in TBS pH 7.4 + 0.5% BSA.
- 15 15. Incubate 28-30 °C, 100 RPM, 1 hr.
16. Wash tape strip with TBS pH 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
17. Place tape strip in new 6 well plate.
- 20 18. Place magnet on surface of tape strip.
19. Remove magnet after 3.0 min.
20. Wash tape strip with TBS pH 7.4, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
21. Place tape strip in new 6 well plate.
- 25 22. Add 2.0 ml peroxidase substrate (ABTS).
23. Incubate 28-30 °C, 100 RPM, 15-30 min, read absorbency at 405nm.
24. Alternative measure of *C. albicans* is to fix the tape strip with 2.5 % Gluteraldehyde after step 11.
- 30 25. Wash tape strip with TBS pH 7.4, holding tape strip with tweezers, use eyedropper to flush tape strip twice.
26. Stain with Calcoflour white.
27. Visually enumerate yeast using fluorescent microscope.



Table 1 outlines the effectiveness of the present invention at magnetically removing *C. albicans* attached to skin.

Table 1

Treatment of Skin with Attached Yeast	HRP Activity ABS 405nm	% Removal of HRP Activity
No Treatment	1.055	
No Treatment	0.844	
Plastic Film	0.802	15.5
Magnet Covered with Plastic Film	0.350	63.2

Figures 2 and 3 show the effectiveness of the present invention at removing *E. coli* and *C. albicans* respectively. As can be seen, the use of the magnetic particle greatly enhances the removal of contaminants from a surface such as skin.

Therefore, as these Examples indicate, the present invention offers a highly effective means for removing contaminants from a surface by utilizing a magnetic particle having means attached thereto to selectively remove the surface contaminant. Additionally, the present invention provides for methods of removing surface contaminants using these magnetic particles and means for removing the magnetic particles from the surface.

## CLAIMS

1. A surface contaminant removing system  
5 comprising:

a particle having a magnetic metal element and  
means on the particle for selectively binding a contaminant on  
a surface;

a carrier for applying the particle to the surface;

10 a magnet; and

means for placing the magnet sufficiently adjacent  
the surface such that the particle and the bound contaminant  
can be removed from the surface by exposure to the magnet.

15 2. The system of Claim 1, wherein the carrier  
is selected from a lotion, a cream, a spray, a solution, a non-  
magnetic, cellulosic wipe, or a non-magnetic, polymeric wipe.

20 3. The system of Claim 2, wherein from about  
0.001 to about 10 mg of particles will be included per  
milliliter of carrier.

25 4. The system of Claim 2, wherein from about  
0.1 to about 1.0 mg/ml of particles will be included per  
milliliter of carrier.

30 5. The system of Claim 1, wherein the means  
thereon for selectively binding a surface contaminant is a  
ligand.

35 6. The system of Claim 5, wherein the ligand  
is an antibody, a cell surface receptor, a plant lectin, *dolichos*  
*biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens*  
*culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex*  
*europaeus*, *vicia villosa*, or a combination thereof.

7. The system of Claim 1, wherein the means thereon for selectively binding a surface contaminant is an electrostatic interaction.

8. The system of Claim 1, wherein the magnetic particle has a positive charge.

9. The system of Claim 1, wherein the magnetic particle has a negative charge.

10. The system of Claim 1, wherein the contaminant is a bacteria, yeast, toxin, enzyme, debris, or a combination thereof.

11. The system of Claim 1, wherein the surface is skin.

12. The system of Claim 1, wherein the particle has a diameter of less than about 25  $\mu\text{m}$ .

13. The system of Claim 1, wherein the particle has a diameter of between about 1-10  $\mu\text{m}$ .

14. The system of Claim 1, wherein the particle has a diameter of between about 3-4  $\mu\text{m}$ .

15. The system of Claim 1, wherein the magnetic metal element comprises iron and the particle comprises between about 1% to 25% by weight of iron.

16. The system of Claim 1, wherein the magnetic metal element comprises iron and the particle comprises between about 10% to 20% by weight of iron.

17. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a bandage having the magnet contained therein.

5 18. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a diaper having the magnet contained therein.

10 19. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise an adhesive strip having the magnet contained therein.

15 20. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a facial tissue having the magnet contained therein.

21. A method for removing a surface contaminant comprising

20 applying to a contaminated surface a particle having a magnetic metal element and means on the particle for selectively binding a contaminant on a surface; and

25 removing the particle and the bound contaminant from the surface by exposure to a magnetic force using an article having a magnet.

30 22. The method of Claim 21, wherein the means thereon for selectively binding a surface contaminant is a ligand.

35 23. The method of Claim 22, wherein the ligand is an antibody, a cell surface receptor, a plant lectin, *dolichos biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex europaeus*, *vicia villosa*, or a combination thereof.

24. The method of Claim 21, wherein the means thereon for selectively binding a surface contaminant is an electrostatic interaction.

25. The method of Claim 21, wherein the magnetic particle has a positive charge.

26. The method of Claim 21, wherein the magnetic particle has a negative charge.

27. The method of Claim 21, wherein the contaminant is a bacteria, yeast, toxin, enzyme, debris, or a combination thereof.

28. The method of Claim 21, wherein the surface is skin.

29. The method of Claim 21, wherein the particle has a diameter of less than about 25  $\mu\text{m}$ .

30. The method of Claim 21, wherein the particle has a diameter of between about 1-10  $\mu\text{m}$ .

31. The method of Claim 21, wherein the particle has a diameter of between about 3-4  $\mu\text{m}$ .

32. The method of Claim 21, wherein the magnetic metal element comprises iron and the particle comprises between about 1% to 25% by weight of iron.

33. The method of Claim 21, wherein the magnetic metal element comprises iron and the particle comprises between about 10% to 20% by weight of iron.

34. The method of Claim 21, wherein the article having a magnet comprises a bandage having the magnet contained therein.

5                   35. The method of Claim 21, wherein the article having a magnet comprises a diaper having the magnet contained therein.

10                   36. The method of Claim 21, wherein the article having a magnet comprises an adhesive strip having the magnet contained therein.

15                   37. The method of Claim 21, wherein the article having a magnet comprises a facial tissue having the magnet contained therein.

1/2

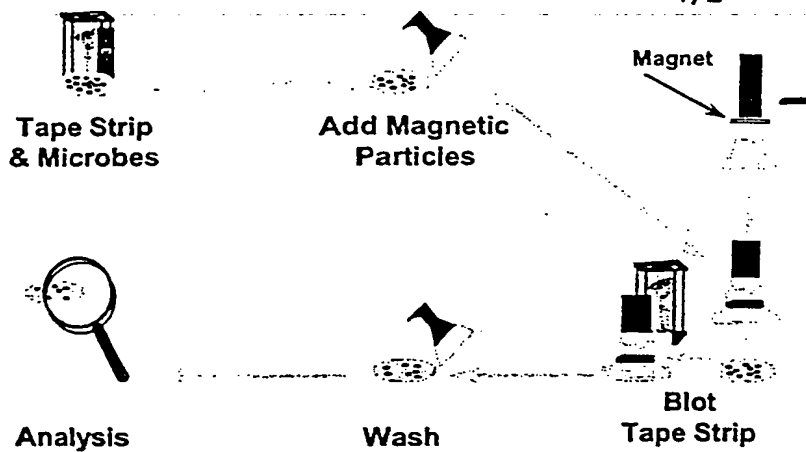
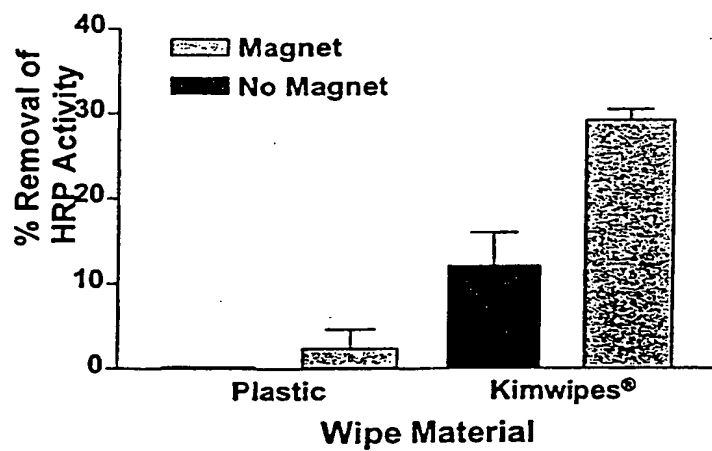


Figure 2.



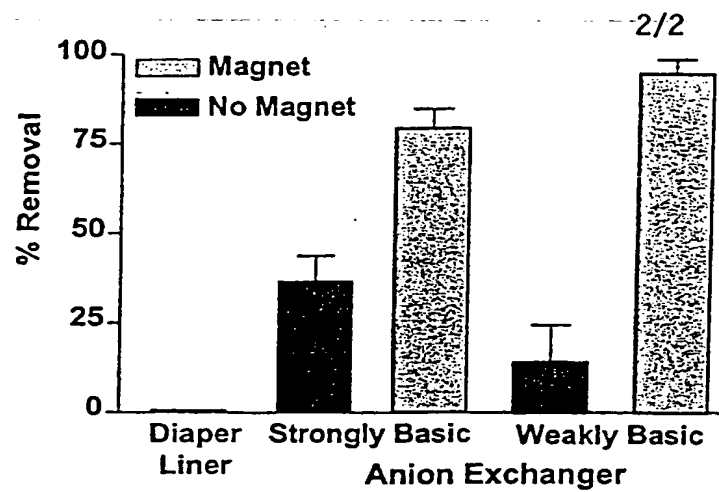


Fig 3



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/41054

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A61K7/48 A61K7/50

According to the International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data bases consulted during the international search (name of data base and, where practical, search terms used)

CHEM ABS Data, EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

**\* Special categories of cited documents**

\*A\* document defining the general state of the art which is not considered to be of particular relevance

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\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

\*G\* document member of the same patent family

Date of the actual completion of the international search

19 February 2001

Date of mailing of the international search report

27/02/2001

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# INTERNATIONAL SEARCH REPORT

Int lional Application No

PCT/US 00/41054

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

Int .tional Application No

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CORRECTED VERSION

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
26 April 2001 (26.04.2001)

PCT

(10) International Publication Number  
WO 01/028512 A1

(51) International Patent Classification<sup>7</sup>: A61K 7/48, 7/50

(21) International Application Number: PCT/US00/41054

(22) International Filing Date: 3 October 2000 (03.10.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
(9)/420,472 19 October 1999 (19.10.1999) US

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

(48) Date of publication of this corrected version:

8 August 2002

(15) Information about Correction:

see PCT Gazette No. 32/2002 of 8 August 2002, Section II

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: SELECTIVE REMOVAL OF CONTAMINANTS FROM A SURFACE USING ARTICLES HAVING MAGNETS

(57) Abstract: A system and method for removing contaminants from a surface. The system is designed to use particles having means thereon which are capable of selectively binding to a contaminant or contaminants of interest. The particles are applied to the surface whereupon the contaminants bind to the particle. When the particle is removed, the desired contaminants are also removed. Preferably, the present invention utilizes magnetic particles having iron therein. The particles may then be readily removed using magnets. The means for binding the contaminant to the particle preferably comprise a ligand or a charge specifically designed to remove the contaminant of interest. The particles may be included in a carrier to facilitate their application to the surface. The invention is especially useful for the removal of contaminants from skin.

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## SELECTIVE REMOVAL OF CONTAMINANTS FROM A SURFACE USING ARTICLES HAVING MAGNETS

### FIELD OF THE INVENTION

15

The present invention is directed to a system and method whereby contaminants may be selectively removed from skin. In particular, the present invention is directed to a system and method which uses particles having a degree of magnetism wherein the particles are constructed and arranged to remove particular contaminants, such as microbial contaminants and debris, further wherein the particles and the contaminants are then removed from the skin using articles containing magnets.

20

### BACKGROUND OF THE INVENTION

25

Humans have vast amounts of debris and microbes existing in their bodily fluids and on their skin. Many of the microbes are beneficial to the health and well-being of the individual. However, many of these microbes are contaminants which are not beneficial. Many of these non-beneficial microbes exist in body fluids which contact the skin, such as tears, perspiration, oils, nasal secretions, and bodily waste. The microbes may also exist in wounds. These microbes, along with debris contaminants, may irritate the skin causing a variety of skin problems such as rashes,

30

breakouts, clogged pores, or discoloration of the skin or, with wounds, slow down the rate at which the wound will heal.

Many different products have been produced to help eliminate the problems associated with debris and the non-beneficial microbes. Different cleaning products are used which include detergents. These detergents effectively remove excess oils and fluids, thereby reducing the number of both beneficial and non-beneficial microbes. However, the non-beneficial microbes still exist on the skin, just in lower numbers. Additionally, if too much oil is removed from the skin, then dryness of the skin could result.

Other products have introduced microbiocides which are effective at killing all microbes on the skin. However, since these microbiocides eliminate beneficial microbes as well as non-beneficial microbes, these products destroy beneficial skin ecology and thus have a negative impact on skin health.

Accordingly, what is needed is a system and method of removing debris and non-beneficial microbes from skin without removing beneficial microbes to help reduce the skin problems associated with the non-beneficial microbes while maintaining skin health.

## SUMMARY OF THE INVENTION

The present invention is directed to a system and method of removing microbial contaminants from skin. The system utilizes receptor materials which selectively bind to the microbe or microbes of interest. The receptor materials are placed on the surface of the skin wherein they attach to and bind the microbes. Then, the receptor material and bound microbes are removed from the skin. This allows non-beneficial microbes to be removed while beneficial microbes remain, thereby maintaining skin health or expediting the healing of wounds.

The system preferably includes the use of particles onto which the receptor materials are placed. These particles are designed to be placed on the skin wherein the receptor materials may bind to the desired microbes. Then, means are provided which remove the particles and the accompanying receptor material and microbes from the surface of the skin.

Preferably, the present invention utilizes particles which have a magnetic charge. Then, after these magnetic particles are used to remove the microbes, articles having magnets contained therein or thereon may be used to remove the magnetic particles from the skin.

Accordingly, it is an object of the present invention to provide a system which can selectively attach and remove desired microbes.

It is another object of the present invention to provide a system which maintains skin health by removing non-beneficial microbes while permitting beneficial microbes to remain on the skin.

It is still another object of the present invention to provide a system which removes non-beneficial microbes while not drying or otherwise damaging the skin.

It is still another object of the present invention to provide a system which utilizes magnetic particles and magnets to aid in the selective removal of the non-beneficial microbes.

It is still another object of the present invention to provide a method of removing non-beneficial microbes from skin.

It is still another object of the present invention to provide a method of removing non-beneficial microbes by utilizing particles which selectively bind to the non-beneficial microbes on the skin and, upon removal of the particles, carry off the non-beneficial microbes.

It is still another object of the present invention to provide a method of removing non-beneficial microbes by utilizing magnetic particles and magnets.

5 The present invention can also be used with a multitude of different personal care items such as diapers, tissues, feminine products, wipes, bandages, and cleansing materials.

10 These and other objects and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiments.

### BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 outlines the test procedure by which an embodiment of the present invention was used to determine the effectiveness of the magnetic test strips.

Figure 2 is a graphical representation of the effectiveness of the present invention at removing *E. coli* attached to skin.

20 Figure 3 a graphical representation of the effectiveness of the present invention at removing *C. albicans* from skin using Magnetic Cellulose Particles.

### DETAILED DESCRIPTION

25 The present invention is directed to a system and method for removing contaminants from skin. The system may be used to remove a wide range of contaminants such as debris or microbes. The system preferably utilizes ligands which bind to the contaminant of interest. Then, the ligands and the bound contaminants are removed leaving desirable  
30 microbes to maintain skin health.

The ligands are associated with particulate materials which are applied to the skin whereupon the ligand or charge can bind to the contaminant of interest. Then, means are provided which remove the particulate material. In  
35 the preferred embodiment of the present invention, the



particulate materials have a magnetic charge and these magnetic particles are removed through the use of article having magnets contained therein or thereon. Depending on the desired use, these magnets may be located within a personal care product. Preferably, the system employs reactive superparamagnetic monodispersed microspheres (SMM) that are coated with ligands to specifically bind the target microbes.

Alternatively, instead of attaching a ligand, the magnetic particles may be either positively or negatively charged to thereby attract and bind other desired microbes and contaminants. The charge may be given to the particle by at least two methods. One would be to use material that already has the appropriate charge. This would be example by the use of cellulose to impart an overall negative charge. Conversely, chitin could be used to impart an overall positive charge to the particle. The second method would be to modify the materials by chemical means to change the charge characteristic of the surface. For example, addition of amines would impart a positive charge addition of carboxyl groups a negative charge.

Native silanol groups on the surface of silica microspheres are readily reacted with aqueous or solvent-based silane coupling agents to yield preactivated silica microspheres with a large variety of surface functional groups. Examples include chloromethyl, carboxyl, and amino groups. Oligonucleotides can be covalently bound to surface-modified silica via the 5'-amino end. Lipids can be bound via the carboxyl group on the fatty acid chain and propylamine surface groups on the silica.

The present invention also includes methods of removing contaminants from skin by applying particles having the ability to selectively bind to a contaminant or contaminants of interest. Then, the particles are removed from the skin to clear away the undesirable contaminants. By "selectively bind" is meant that the particles can adhere to certain intended

contaminants and not adhere to certain other non-intended materials.

In the preferred embodiment, the present invention utilizes magnetic particles. Preferably, these magnetic particles comprise a particle containing iron. Preferably, the particle is non-toxic and is capable of binding a ligand thereto. Particles useful in the present invention include those made from natural polymers, random copolymers, or plastics. Representative examples include natural polymers such as cellulose; random copolymers such as polybutylene copolymer, polyethylene, polypropylene copolymers, polyethylene elastomers; and plastics such as polystyrene, polyethylene, polypropylene, rayon, nylon, polyvinylidene chloride, and polyesters, chitin, starch, dextran and modified-starch. Silica could be used as an inorganic carrier. Other inorganic carriers might include clays. The type of particle used will vary depending several considerations, including the intended use or the contaminant to be removed. However, in general, natural polymers, such as cellulose, impregnated with iron are the preferred type of particle.

The size of the particle may also vary depending on the intended use or the product in which the particle is to be used. However, if the particle is too large, it may aggravate the skin as it is applied. Therefore, in general, the preferred particle are smaller in size. Preferably, the particles are less than about 25  $\mu\text{m}$  in diameter. More preferably, the particles are from about 3-4  $\mu\text{m}$  in diameter.

The amount of iron contained within each particle will vary depending on the amount of charge desired, the overall size of the particle, the carrier within which the particles will be applied to the skin, if any, and the location and number of magnets used to remove the particle. However, in general, the particles will comprise from about 1% to about 25% by weight of iron. More preferably, the particles will

comprise from about 10% to about 20% by weight of iron. This will result in the particle having a magnetic mass susceptibility of from about 50,000,000 to about 200,000,000 m<sup>3</sup>/kg.

5                   Once the desired particle type, size and iron content have been selected, then the particle may be modified to either attach a ligand thereto or charged to obtain the desired polarity. As discussed previously, the choice between  
10                   a ligand or ligands and a charge will depend upon the type of contaminant to be removed and will affect the composition of the particle. If a charge is used, the charge may either be a positive charge or a negative charge. If a ligand is used, it may be selected from a wide variety of useful ligands.

15                   A positively charged particle is capable of being used to remove yeast and bacteria (negatively charged) and any negatively charged molecule. Examples of particles useful as positively charged particles include, but are not limited to, diethylaminoethyl,                   ciethyl[2-hydroxypropyl]aminoethyl, polyethyleneimine, triethylaminohydroxypropyl, quaternary  
20                   ammonium,                   quaternary                   alkylamine,                   quaternary alkylanolamine,                   trimethylbenzylammonium, dimethylethanolbenzylammonium, polyamine, alkylamine, dimethylethanolamine, octadecyldimethyltrimethoxysilpropylammonium                   chloride,  
25                   and kymene.

30                   A negatively charged molecule may be used to remove protein and other biological contaminants, not including yeast or bacteria. Examples of particles useful as positively charged particles include, but are not limited to, carboxymethyl cellulose, sulfopropyl cellulose, cellulose phosphate, DOWEX®, DUOLITE®, AMBERLITE®, bentonite, and chitin.

                  A large number of ligands may be used in the present invention. These ligands include plant lectins and

antibodies among others. Furthermore, extracts of plants and natural products may also be used.

Plant lectins useful in the present invention include, but are not limited to, lentil lectin, wheat germ lectin, dolichos biflorus, galanthus nivalis, glycine max, heli pomatia, lens culinaris, phaseolus vulgaris, phytolacca americana, ulex europaeus, and vicia villosa. These lectins are useful at removing microbial materials, and especially any cells with mannopyranosyl or glucopyranosyl residues on the membrane surface. They may also help in the removal of proteins or skin debris with similar characteristics. Other microbes which may be removed include those having glucose, mannose, or n-acetyl-glucosaminyl residues in the microbes cell wall and other skin debris material.

Other ligands which may be used include *dolichos biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex europaeus*, and *vicia villosa*.

Antibodies useful in the present invention include those having specific antibodies for any microbe associated cell wall or membrane component. Other ligands useful in the present invention include those that use cell surface receptors specific for microbes. These include, but are not limited to, *Staphylococcus*, *Streptococcus*, *Candida*, and *Propionibacterium*. All of these are specific for cell surface receptors which bind glycosides. Those glycosides could be attached to the magnetic particle.

If a ligand is used as the means for removing the contaminant, then the ligand must be attached to the particle such that when the particle is applied to the skin, the ligand is able to bind with the contaminant or contaminants of choice and remove these contaminants when the particle is removed from the skin. There are a plurality of known methods which may be used to attach the ligand to the particle. However, the

preferred methods for the present invention include direct adsorption and covalent attachment.

Direct adsorption involves adsorbing the ligand onto the surface of the particle. Simply adsorbing protein, especially polyclonal IgG, on the surface of polystyrene microspheres is successful more than 95% of the time. For maximum surface coverage (up to a monolayer), buffer pH should be at, or slightly more basic than, IgG's isoelectric point (that is, pH 8), where the protein is in its most relaxed, compact form. Tris buffer (pH 8.0) and phosphate buffer (pH 7.4) work well. The Fc and Fab portions of IgG adsorb differently in response to pH changes. A slightly alkaline pH optimizes adsorption of the Fc portion and ensures relative suppression of Fab adsorption.

As an alternative to simple adsorption, IgG and serum albumin (human or bovine) can be mixed and then adsorbed simultaneously. One commercial protocol calls for a weight ratio of 1 IgG to 10 albumin in the coadsorption mixture. Adsorption can be followed by glutaraldehyde cross-linking of the mixed proteins on the microsphere surface.

In covalent bonding, the ligand is covalently bonded to the particle. For example, haptens and other low-molecular-weight labels, which on their own might not adsorb well or remain attached, can be covalently bound to proteins (such as BSA), dextran, polylysine, or other polymers that adsorb well. Another alternative is to adsorb the polymer on the particles and then couple the hapten or other label. These polyhaptens are used commercially. Another embodiment is to adsorb peptide onto the microspheres and then covalently link more peptide onto the surface.

Also, any polyclonal antibody (PoAb) may also be used, such as those from mouse, goat, rabbit, pig, or bovine. These polyclonal antibodies adsorb well and attach to microspheres to form generic microspheres. These then capture any of several poorly adsorbing monoclonal antibodies

(MoAb). In theory, a manufacturer can make a series of tests (or assays) from one PoAb preparation.

Some evidence indicates that one can attach 10-40% more protein covalently than by adsorption. When the desired protein coverage is low, covalent coupling may provide more-precise control of the coating level. Covalent coupling binds protein more securely, an asset in production of tests or assays that are so sensitive that they would be influenced by minute quantities of IgG that might leach off the particles over time. The covalent bond is more thermally stable.

Native silanol groups on the surface of silica microspheres are readily reacted with aqueous or solvent-based silane coupling agents to yield preactivated silica microspheres with a large variety of surface functional groups. Examples include chloromethyl, carboxyl, and amino groups. DNA and RNA are isolated from serum by adsorption onto silica in the presence of chaotropic agents. Oligonucleotides can be covalently bound to surface-modified silica via the 5-amino end. Lipids can be bound via the carboxyl group on the fatty acid chain and propylamine surface groups on the silica.

After the particles have been charged or attached with a ligand, they are then ready to be applied to the skin to remove contaminants therefrom. While the particles may be applied directly to the skin, it is preferred that they be included with a carrier designed to aid the application of the particles to the skin while reducing the number of particles needed to effectively remove the desired contaminants. The carrier may be any means that permit the effective distribution of the particles over the desired area of the skin. These carriers include, but are not limited to, lotions, creams, sprays, or solutions. Other natural carriers may be used, such as alginate or chitosan. Additionally, the particles may be

applied using a non-magnetic, cellulosic or polymeric wipe which is wiped across the surface of the skin.

5 The amount of particles added to the carrier will depend on several factors including the carrier used, the contaminants to be removed and the amount of contaminants, among others. In general, from about 0.001 to about 10 mg of particles will be included per milliliter of carrier. More preferably, the amount of particles will be from about 0.1 to about 1.0 mg/ml.

10 As previously discussed, the present invention preferably uses magnetic particles. Magnetic particles are used such that they may be easily removed through the use of magnets. The magnets are associated with a product, such as a personal care item. The manner in which the particles are  
15 applied to the surface and the type of product used to remove the particles will vary, depending on the contaminant to be removed and the surface area to be treated.

The magnets used in the present invention are selected so as to be incorporated into the personal care product  
20 such that they are still capable of removing the magnetic particles. The magnets may be incorporated into both woven and non-woven materials, depending on the product. Additionally, the woven and non-woven materials may be composed of natural or synthetic fibers, or a mixture of both.  
25 For example, in one embodiment, the magnets may be incorporated into facial tissues, which comprise plant fiber. In another embodiment, the magnets may be incorporated into a non-woven fabric, such as a diaper or a wipe. However, since these two embodiments result in different contact of the  
30 product with the skin, the products must be designed accordingly. For facial tissues, the magnets will come into close contact with the skin. Therefore, the number, size and/or strength of the magnets will be different when compared to magnets placed inside a diaper, which do not  
35 directly contact the skin, yet must still be able to remove

magnetic particles which may have been incorporated into lotion or powder applied before the diaper was put on.

5 The present invention also includes methods of removing contaminants using the system of the present invention. While it is expected that the system is capable of removing contaminants, such as debris or microbes, from a skin surface, it is also contemplated that the mechanisms described below may also permit the system to be used to remove contaminants from a wide variety of surfaces including, but not limited to, skin, floors, windows, pets, automobiles, watercraft, and counter tops.

10 In use, means for removing the contaminant are associated with a particle. As previously discussed, these means may involve the attachment of a ligand or generating a charge on the particle. After the means for removing the contaminant are associated with the particle, the particle is then applied to the surface. The particles may either be applied directly, such as using a wipe, or may be included in a carrier which is applied to the surface. After the particles have been applied, the contaminants to be removed bind to the means for removing the contaminant. Then, the particles are removed from the surface using means for accomplishing the same. When the particle is removed from the surface the contaminant is also removed.

25 This invention is further illustrated by the following embodiments, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

30 In one embodiment, the magnetic particles may be placed in a carrier, such as a cream, lotion, spray or solution,



and applied to an open wound. These particles could be associated with a ligand capable of removing bacteria from the wound. Then, the magnetic particles could be located in the gauze or bandage which is wrapped around the wound. Once the bandage contacted the wound, the magnets would pull the magnetic particles and contaminants from the wound. In a similar manner, the particles may be associated with a charge or another ligand and used to treat a variety of different rashes or infections.

In another embodiment, the magnetic particles may be associated with a ligand or charge that is capable of binding to microbes existing in bodily wastes. Then, the particles may be applied to, for example, a baby using a baby wipe, powder or lotion. The particles would bind with the microbes. Then, a diaper having magnets contained therein may be placed on the baby, wherein the magnets would remove the magnetic particles and contaminants from the skin of the baby, helping to prevent rashes. Similar embodiments may be used with feminine articles or adult incontinence devices.

In still another embodiment, the particles may be used to help clear pores and prevent breakouts of the skin. The particles would be associated with a ligand or charge that is capable of binding to debris or microbes existing on the skin surface. The particles may be included in a carrier such as a cream or lotion. Then, the particles are applied to the skin surface whereupon they bind with the debris or microbes. Then, an adhesive strip having magnets contained therein may be applied to the skin. When the strip is removed, the magnetic particles and contaminants would also be removed, helping to clear the pores. Alternatively, a facial wipe may be used in lieu of the adhesive strip.

In still another embodiment, the particles may be used to relieve the symptoms associated with sinus problems. Irritation of the skin around the nose may be associated with

microbes in the mucous. To remove these microbes, particles having the necessary ligand or charge may be applied to the nose using a carrier such as cream, lotion, or facial tissue. Then, the particles and the microbes bound thereto may be removed using another facial tissue having magnets contained therein.

As can be seen, the particles of the present invention may be used in many different embodiments depending upon the contaminant to be removed, the surface being treated, the carrier used, and the means for removing the particles and contaminants. It should be understood, of course, that the foregoing embodiments relate only to some of the preferred embodiments of the present invention and that numerous modifications or alterations may be made therein without departing from the spirit and the scope of the invention as set forth in the appended claims.

## EXAMPLES

In the Examples, *ex-vivo* skin test strips were prepared. These strips were then used to determine the effectiveness of the present invention at removing *C. albicans* or *E. coli* from skin. Figure 1 outlines the magnetic removal protocol used for these Examples. The Examples were performed as follows:

### Procedure:

1. Make tape strips, 5 pulls per tape strip on forearm.
2. Place tape strips in wells of 6 well plate.
3. Block with 2.0 ml 5% Bovine Serum Albumin (BSA) in Phosphate Buffered Saline (PBS), pH 7.2.
4. Incubate 30-32 °C, 100 RPM, 1 hr.
5. Aspirate wells of 6 well plate dry.
6. Wash tape strip with Tris Buffered Saline (TBS pH) 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.

7. Add 1.0 ml ( $10^6$  CFU/ml) *C. albicans* or *E. coli* in TBS pH 7.4 to each well.
8. Add 1.0 ml Typtic Soy Broth (TSB) to each well.
9. Incubate 30-32 °C, 100 RPM, 1 hr.
- 5 10. Aspirate wells of 6 well plate dry.
11. Wash tape strip with TBS pH 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
- 10 12. Add 2.0ml 1/200 Rabbit anti-*C. albicans*-Horseradish Peroxidase (HRP) or Rabbit anti-*E.coli* -HRP in TBS pH 7.4 + 0.5% BSA.
13. Incubate 28-30 °C, 100 RPM, 1 hr.
14. Add 2.0ml 1/200 Sheep anti-rabbit-paramagnetic bead in TBS pH 7.4 + 0.5% BSA.
- 15 15. Incubate 28-30 °C, 100 RPM, 1 hr.
16. Wash tape strip with TBS pH 7.4 + 0.5% BSA, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
17. Place tape strip in new 6 well plate.
- 20 18. Place magnet on surface of tape strip.
19. Remove magnet after 3.0 min.
20. Wash tape strip with TBS pH 7.4, holding tape strip with tweezers, use eye-dropper to flush tape strip twice.
21. Place tape strip in new 6 well plate.
- 25 22. Add 2.0 ml peroxidase substrate (ABTS).
23. Incubate 28-30 °C, 100 RPM, 15-30 min, read absorbency at 405nm.
24. Alternative measure of *C. albicans* is to fix the tape strip with 2.5 % Gluteraldehyde after step 11.
- 30 25. Wash tape strip with TBS pH 7.4, holding tape strip with tweezers, use eyedropper to flush tape strip twice.
26. Stain with Calcoflour white.
27. Visually enumerate yeast using fluorescent microscope.

Table 1 outlines the effectiveness of the present invention at magnetically removing *C. albicans* attached to skin.

Table 1

Treatment of Skin with Attached Yeast	HRP Activity ABS 405nm	% Removal of HRP Activity
No Treatment	1.055	
No Treatment	0.844	
Plastic Film	0.802	15.5
Magnet Covered with Plastic Film	0.350	63.2

Figures 2 and 3 show the effectiveness of the present invention at removing *E. coli* and *C. albicans* respectively. As can be seen, the use of the magnetic particle greatly enhances the removal of contaminants from a surface such as skin.

Therefore, as these Examples indicate, the present invention offers a highly effective means for removing contaminants from a surface by utilizing a magnetic particle having means attached thereto to selectively remove the surface contaminant. Additionally, the present invention provides for methods of removing surface contaminants using these magnetic particles and means for removing the magnetic particles from the surface.

## CLAIMS

1. A surface contaminant removing system  
5 comprising:

a particle having a magnetic metal element and  
means on the particle for selectively binding a contaminant on  
a surface;

a carrier for applying the particle to the surface;

10 a magnet; and

means for placing the magnet sufficiently adjacent  
the surface such that the particle and the bound contaminant  
can be removed from the surface by exposure to the magnet.

15 2. The system of Claim 1, wherein the carrier  
is selected from a lotion, a cream, a spray, a solution, a non-  
magnetic, cellulosic wipe, or a non-magnetic, polymeric wipe.

3. The system of Claim 2, wherein from about  
20 0.001 to about 10 mg of particles will be included per  
milliliter of carrier.

4. The system of Claim 2, wherein from about  
0.1 to about 1.0 mg/ml of particles will be included per  
25 milliliter of carrier.

5. The system of Claim 1, wherein the means  
thereon for selectively binding a surface contaminant is a  
ligand.

30 6. The system of Claim 5, wherein the ligand  
is an antibody, a cell surface receptor, a plant lectin, *dolichos*  
*biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens*  
*culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex*  
35 *europaeus*, *vicia villosa*, or a combination thereof.

7. The system of Claim 1, wherein the means thereon for selectively binding a surface contaminant is an electrostatic interaction.

8. The system of Claim 1, wherein the magnetic particle has a positive charge.

9. The system of Claim 1, wherein the magnetic particle has a negative charge.

10. The system of Claim 1, wherein the contaminant is a bacteria, yeast, toxin, enzyme, debris, or a combination thereof.

11. The system of Claim 1, wherein the surface is skin.

12. The system of Claim 1, wherein the particle has a diameter of less than about 25  $\mu\text{m}$ .

13. The system of Claim 1, wherein the particle has a diameter of between about 1-10  $\mu\text{m}$ .

14. The system of Claim 1, wherein the particle has a diameter of between about 3-4  $\mu\text{m}$ .

15. The system of Claim 1, wherein the magnetic metal element comprises iron and the particle comprises between about 1% to 25% by weight of iron.

16. The system of Claim 1, wherein the magnetic metal element comprises iron and the particle comprises between about 10% to 20% by weight of iron.

17. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a bandage having the magnet contained therein.

5 18. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a diaper having the magnet contained therein.

10 19. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise an adhesive strip having the magnet contained therein.

15 20. The system of Claim 1, wherein the means for placing the magnet sufficiently adjacent the surface comprise a facial tissue having the magnet contained therein.

21. A method for removing a surface contaminant comprising

20 applying to a contaminated surface a particle having a magnetic metal element and means on the particle for selectively binding a contaminant on a surface; and

25 removing the particle and the bound contaminant from the surface by exposure to a magnetic force using an article having a magnet.

30 22. The method of Claim 21, wherein the means thereon for selectively binding a surface contaminant is a ligand.

35 23. The method of Claim 22, wherein the ligand is an antibody, a cell surface receptor, a plant lectin, *dolichos biflorus*, *galanthus nivalis*, *glycine max*, *heli pomatia*, *lens culinaris*, *phaseolus vulgaris*, *phytolacca americana*, *ulex europaeus*, *vicia villosa*, or a combination thereof.

24. The method of Claim 21, wherein the means thereon for selectively binding a surface contaminant is an electrostatic interaction.

25. The method of Claim 21, wherein the magnetic particle has a positive charge.

26. The method of Claim 21, wherein the magnetic particle has a negative charge.

27. The method of Claim 21, wherein the contaminant is a bacteria, yeast, toxin, enzyme, debris, or a combination thereof.

28. The method of Claim 21, wherein the surface is skin.

29. The method of Claim 21, wherein the particle has a diameter of less than about 25  $\mu\text{m}$ .

30. The method of Claim 21, wherein the particle has a diameter of between about 1-10  $\mu\text{m}$ .

31. The method of Claim 21, wherein the particle has a diameter of between about 3-4  $\mu\text{m}$ .

32. The method of Claim 21, wherein the magnetic metal element comprises iron and the particle comprises between about 1% to 25% by weight of iron.

33. The method of Claim 21, wherein the magnetic metal element comprises iron and the particle comprises between about 10% to 20% by weight of iron.



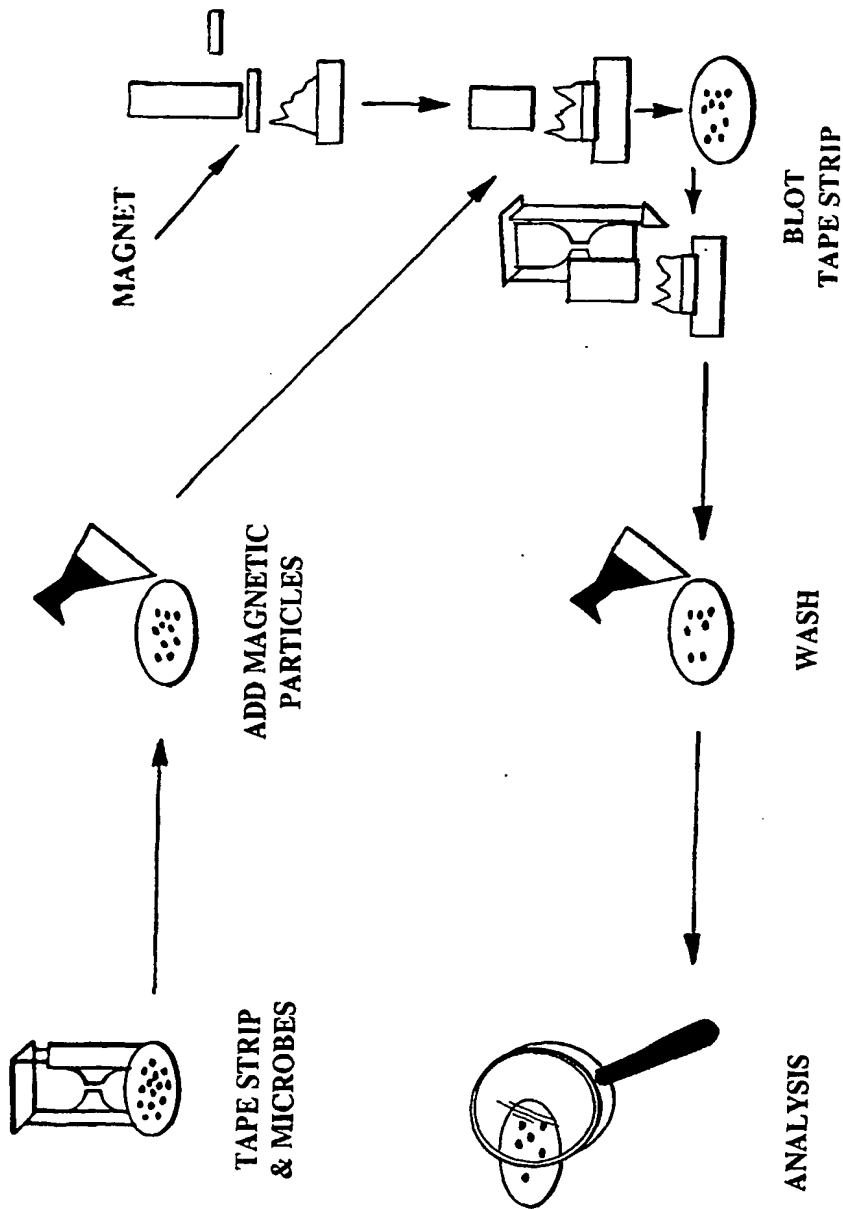
34. The method of Claim 21, wherein the article having a magnet comprises a bandage having the magnet contained therein.

5 35. The method of Claim 21, wherein the article having a magnet comprises a diaper having the magnet contained therein.

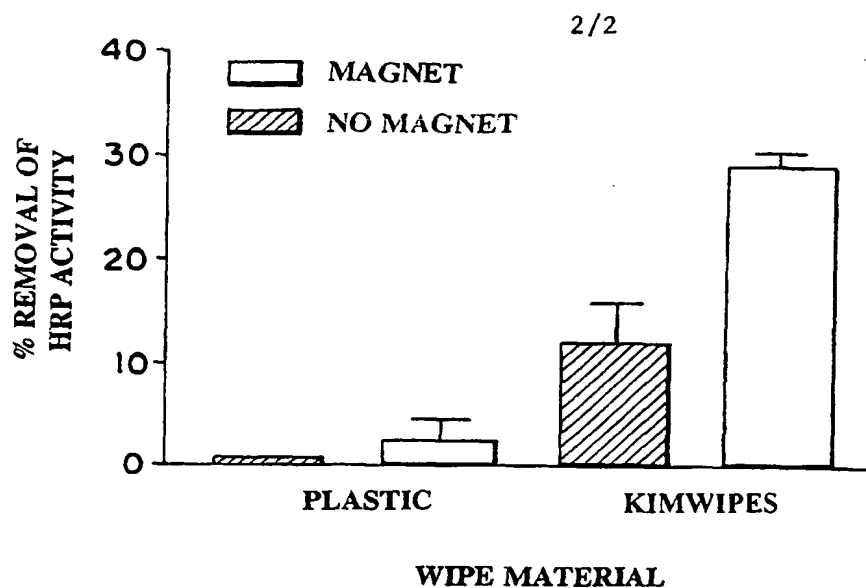
10 36. The method of Claim 21, wherein the article having a magnet comprises an adhesive strip having the magnet contained therein.

15 37. The method of Claim 21, wherein the article having a magnet comprises a facial tissue having the magnet contained therein.

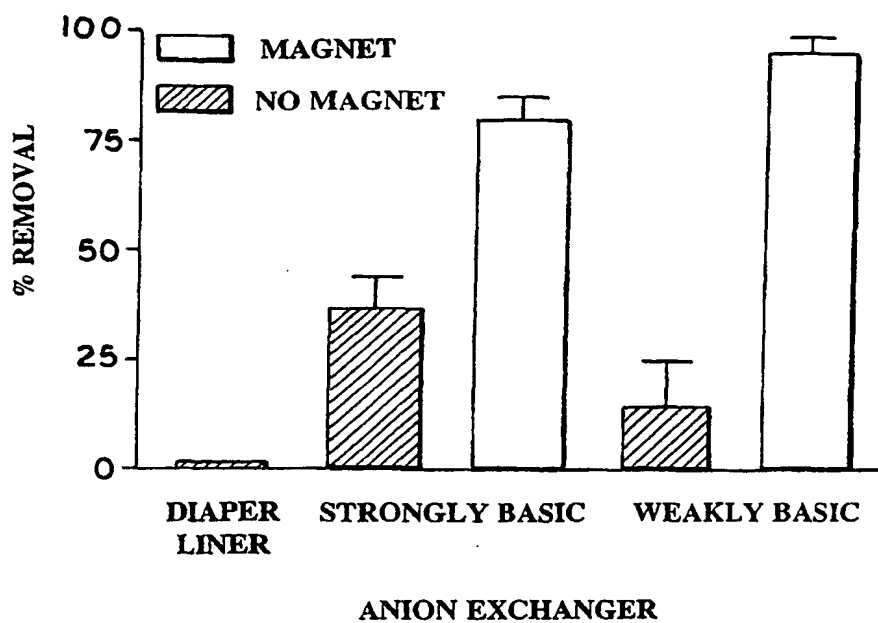
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**Fig. 1**



**Fig. 2**



**Fig. 3**

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/41054

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 A61K7/48 A61K7/50

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

CHEM ABS Data, EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 268 512 A (R. LAGUERRE) 21 November 1975 (1975-11-21) the whole document	1
A	FR 2 400 883 A (DEUTSCHE NEMECTRON GMBH) 23 March 1979 (1979-03-23) the whole document	1
A	US 5 160 725 A (H. PILGRIMM) 3 November 1992 (1992-11-03) the whole document	1
A	DE 36 29 761 A (BODYWELL AG) 5 March 1987 (1987-03-05) the whole document	1
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Date of the actual completion of the international search

19 February 2001

Date of mailing of the international search report

27/02/2001

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# INTERNATIONAL SEARCH REPORT

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## C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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International Application No

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